CLAIMS

What is claimed is:

1. A power transfer assembly for use in a motor vehicle to transfer drive torque from a powertrain to first and second drivelines, comprising:

an input shaft adapted to be driven by the powertrain;

a first output shaft adapted for connection to the first driveline;

a second output shaft adapted for connection to the second driveline;

a reduction unit having an input member driven by said input shaft and an output member driving said first output shaft;

a range clutch operable in a first range position to couple said input member to said first member for establishing a high-range drive connection therebetween, said range clutch is operable in a second range position to couple said output member to said first output shaft for establishing a low-range drive connection therebetween, and said range clutch is operable in a third position to release said first output shaft from engagement with said input member and said output member;

a range shift mechanism for moving said range clutch between its range positions in response to rotation of a driveshaft;

a torque transfer mechanism for transferring drive torque from said first output shaft to said second output shaft, said torque transfer mechanism including a friction clutch operably disposed between said first and second output shafts and a clutch actuator assembly for applying a clutch engagement force on said friction clutch, said clutch actuator assembly including an electric motor driving said driveshaft, a gearset driven by said driveshaft, and a clutch apply operator having a first member driven by said gearset, a

second member axially moveable between first and second mode positions for controlling the magnitude of said clutch engagement force exerted on said friction clutch, and third member for converting rotary movement of said first member into axial movement of said second member, said third member including means for coordinating movement of said second member between its mode positions with movement of said range clutch between its range positions in response to rotation of said driveshaft; and

a control system for controlling actuation of said electric motor.

2. The power transfer assembly of Claim 1 wherein said input member of said reduction unit is a sun gear driven by said input shaft, said output member is a planet carrier fixed for rotation with said first output shaft, and wherein said reduction unit further includes a ring gear and planet gears supported from said planet carrier that are meshed with said sun gear and said ring gear.

3. The power transfer assembly of Claim 2 wherein said range clutch includes a range sleeve coupled for rotation with said ring gear, said range sleeve is operable in its first range position for coupling said ring gear to said input shaft and said range sleeve is operable in its second range position to brake rotation of said ring gear.

4. The power transfer assembly of Claim 1 wherein said first member of said clutch apply operator is a sector member having a gear segment meshed with said gearset, wherein said second member of said clutch apply operator is a cam member having a tapered drive surface, and wherein said third member of said clutch apply operator is a drive member having a roller engaging said tapered drive surface, and wherein said movement coordinating means includes said drive member having a follower pin extending into a slot formed in said sector member so as to permit relative rotation therebetween.

5. The power transfer assembly of Claim 4 wherein said range shift mechanism converts rotary movement of said driveshaft into axial movement of said range clutch between its three distinct range positions.

6. The power transfer assembly of Claim 4 wherein rotation of said driveshaft in a first direction causes said range clutch to move from its third position to its first position while said sector member is rotated in a first direction to cause said follower pin on said drive member to engage a first end of said slot in said sector member, said roller on said drive member engaging a portion of said tapered drive surface on said cam member for locating said cam member in its first position so as to exert a minimum clutch engagement force on said friction clutch.

7. The power transfer assembly of Claim 6 wherein continued rotation of said driveshaft in said first direction causes said range shift mechanism to retain said range clutch in its first position while engagement of said follower pin with said first end of said slot causes concurrent rotation of said drive member with said sector member, such rotation of said drive member in said first direction causes said roller to engage said tapered drive surface and forcibly urge said cam member to move axially from its first position toward its second position so as to increase the clutch engagement force exerted on said friction clutch.

8. The power transfer assembly of Claim 7 wherein rotation of said driveshaft in a second direction causes said range clutch to move from its third position to its second position while said sector member is rotated in a second direction to cause said follower pin on said drive member to engage a second end of said slot in said sector member, said roller on said drive member engaging a portion of said tapered drive surface on said cam member for locating said cam member in its first position so as to exert a minimum clutch engagement force on said friction clutch.

9. The power transfer assembly of Claim 8 wherein continued rotation of said driveshaft in said second direction causes said range shift mechanism to retain said range clutch in its second position while engagement of said follower pin with said second end of said slot causes concurrent rotation of said drive member with said sector member, such rotation of said drive member in said second direction causes said roller to engage said tapered drive surface and forcibly urge said cam member to move axially from its first position toward its second position so as to increase the clutch engagement force exerted on said friction clutch.

10. The power transfer assembly of Claim 4 wherein said clutch apply operator further includes a thrust member having pins acting on an apply plate of said friction clutch, said cam member arranged to move said thrust member relative to said apply plate.

11. The power transfer assembly of Claim 10 wherein said friction clutch includes a clutch pack operably disposed between said first output shaft and a transfer assembly driving said second output shaft, said transfer assembly including a drum with said pins extending through bores in said drum.

12. The power transfer assembly of Claim 11 wherein said drum includes a hub segment rotatably supported on said first output shaft, and wherein said clutch apply operator is journally supported on said hub segment of said drum.

13. A transfer case for use in a four-wheel drive vehicle having a powertrain and first and second drivelines, comprising:

an input shaft driven by the powertrain;

a first output shaft connected to the first driveline;

a second output shaft connected to the second driveline;

a reduction unit having an input member driven by said input shaft and an output member drivingly connected to said first output shaft;

an axially moveable range sleeve operable in a neutral range position to disconnect said first output shaft from driven connection with said input shaft, in a high-range position to connect said first output shaft for common rotation with said input shaft, and in a low-range position to connect said first output shaft for rotation with said output member of said reduction unit;

a friction clutch operably disposed between said first output shaft and said second output shaft;

an electric motor for selectively driving a driveshaft;

a range shift mechanism for moving said range sleeve between its three distinct range positions in response to rotation of said driveshaft;

a clutch actuator assembly including a rotary drive member with rollers, and a non-rotary cam member having a tapered ramp surface in engagement with said rollers, said cam member being axially moveable relative to said friction clutch between a retracted position whereat said friction clutch is released and an extended position whereat said friction clutch is engaged in response to rotation of said drive member;

a movement coordinating mechanism including a drive gear fixed to said driveshaft; and a rotary sector member having a gear segment meshed with said drive gear, said sector member having an arcuate slot and said drive member includes a follower pin extending into said slot, said slot permitting bi-directional rotation of said driveshaft for moving said range sleeve between its three distinct range positions while said sector member rotates relative to said drive member to maintain said cam member in its retracted position;

a mode selector for permitting selection of different drive modes and generating a mode signal indicative of the drive mode selected;

a sensor for sensing an operational characteristic of the vehicle and generating a sensor signal; and

a controller receiving said mode signal and said sensor signals and controlling actuation of said electric motor in response thereto.

14. The transfer case of Claim 13 wherein a two-wheel high-range drive mode is established when said motor rotates said driveshaft in a first direction to a position for locating said range sleeve in its high-range position and said slot has accommodated rotation of said sector member relative to said drive member such that said cam member is located in its retracted position and said friction clutch is released.

15. The transfer case of Claim 14 wherein a part-time four-wheel high-range drive mode is established when said motor continues to rotate said driveshaft in said first direction to a position where said range shift mechanism maintains said range sleeve in its high-range position and said rotation of said sector member causes said follower pin to engage an end of said slot for rotating said drive member, such rotation of said drive member causes said rollers to ride on said tapered ramp surface of said cam member for moving said cam member from its retracted position toward its extended position for engaging said friction clutch.

16. The transfer case of Claim 15 wherein an adaptive on-demand four-wheel high-range drive mode is established when said motor controls movement of said cam member between its retracted and extended positions in response to said sensor signals.

17. The transfer case of Claim 13 wherein said friction clutch includes a hub fixed for rotation with said first output shaft, a drum operably connected for rotation with said second output shaft, a clutch pack operably disposed between said hub and drum, an apply plate for exerting a clutch engagement force on said clutch pack, and wherein said clutch actuator assembly further includes a force amplifying mechanism for transmitting said clutch engagement force in response to movement of said cam member.

18. The transfer case of Claim 17 wherein said force amplifying mechanism includes disk levers disposed between said drum and said apply plate, and a thrust member for engaging said cam member and said disk levers.

19. The transfer case of Claim 17 wherein said drum includes a cylindrical hub segment supported on said first output shaft, and wherein each of said rotary drive member, said non-rotary cam member, and said sector member are supported on said hub segment of said drum.

20. The transfer case of Claim 13 wherein said tapered ramp surface of said cam member includes four cam surfaces and said drive member includes a pair of rollers, and wherein one pair of opposed cam surfaces are engaged by said pair of rollers to move said cam member when said range sleeve is shifted into its high-range position, and wherein the other pair of opposed cam surfaces are engaged by said rollers to move said cam member when said range sleeve is shifted into its low-range position.

21. A power transfer assembly for use in a full-time four-wheel drive vehicle having a powertrain and first and second drivelines, comprising:

an input shaft driven by the powertrain;

a first output shaft driving the first driveline;

a second output shaft driving the second driveline;

a reduction unit having an input member driven by said input shaft and an output member;

an interaxle differential having an input driven by said output member of said reduction unit and first and second outputs respectively connected to said first and second output shafts;

a range clutch operable in a first range position to establish a high-range drive connection between said input shaft and said input of said interaxle differential, said range clutch is operable in a second range position to establish a low-range drive connection between said input shaft and said input of said interaxle differential, and said range clutch is operable in a third position to release said input of said interaxle differential from drive connection with said input shaft;

a range shift mechanism for moving said range clutch between its range positions in response to rotation of a driveshaft;

a torque transfer mechanism for transferring drive torque from said first output shaft to said second output shaft, said torque transfer mechanism including a friction clutch operably disposed between said first and second output shafts and a clutch actuator assembly for applying a clutch engagement force to said friction clutch, said clutch actuator assembly including an electric motor driving said driveshaft, a gearset driven by

said driveshaft, and a clutch apply operator having a first member driven by said gearset, a second member axially moveable between a first and second mode position for controlling the magnitude of said clutch engagement force exerted on said friction clutch, and third member for converting rotary movement of said first member into axial movement of said second member, said third member including means for coordinating movement of said second member between its mode positions with movement of said range clutch between its range positions in response to rotation of said driveshaft; and

a control system for controlling actuation of said electric motor.

22. The power transfer assembly of Claim 21 wherein said input member of said reduction unit is a sun gear and said output member is a planet carrier, and wherein said reduction unit further includes planet gears supported from said planet carrier and meshed with said sun gear and a ring gear.

23. The power transfer assembly of Claim 22 wherein said range clutch includes a range sleeve coupled for rotation with said ring gear, said range sleeve is operable in its first range position for coupling said ring gear to said input shaft and said range sleeve is operable in its second range position to brake rotation of said ring gear.

24. The power transfer assembly of Claim 21 wherein said first member of said clutch apply operator is a sector member with a gear segment meshed with said gearset, wherein said second member of said clutch apply operator is a cam member having a tapered drive surface, and wherein said third member of said clutch apply operator is a drive member having a roller engaging said tapered drive surface, and wherein said movement coordinating means includes said drive member having a follower pin extending into a slot formed in said sector member so as to permit relative rotation therebetween.

25. The power transfer assembly of Claim 24 wherein rotation of said driveshaft in a first direction causes said range clutch to move from its third position to its first position while said sector member is rotated in a first direction to cause said follow pin on said drive member to engage a first end of said slot in said sector member, said roller on said drive member engaging a portion of said tapered drive surface on said cam member for locating said cam member in its first position so as to exert a minimum clutch engagement force on said friction clutch.

26. The power transfer assembly of Claim 25 wherein continued rotation of said driveshaft in said first direction causes said range shift mechanism to retain said range clutch in its first position while engagement of said follower pin with said first end of said slot causes concurrent rotation of said drive member with said sector member, such rotation of said drive member in said first direction causes said roller to engage said tapered drive surface and forcibly urge said cam member to move axially from its first position toward its second position for increasing the clutch engagement force exerted on said friction clutch.

27. The power transfer assembly of Claim 24 wherein said clutch apply operator further includes a thrust member having pins acting on an apply plate of said friction clutch, said cam member arranged to move said thrust member relative to said apply plate.

28. The power transfer assembly of Claim 27 wherein said friction clutch includes a clutch pack operably disposed between said first output shaft and a transfer assembly driving said second output shaft, said transfer assembly including a drum with said pins extending through bores in said drum.

29. A transfer case for use in a four-wheel drive vehicle having a powertrain and first and second drivelines, comprising:

an input shaft driven by the powertrain;

a first output shaft driving the first driveline;

a second output shaft driving the second driveline;

a reduction unit having an input member driven by said input shaft and an output member;

a differential having an input driven by said output member of said reduction unit, a first output driving said first output shaft, and a second output driving said second output shaft;

an axially moveable range sleeve operable in a neutral range position to disconnect said differential input from driven connection with said input shaft, in a high-range position to establish a first speed ratio driven connection between said differential input and said input shaft, and in a low-range position to establish a second speed ratio drive connection between said differential input and said input shaft;

a friction clutch operably disposed between said first output shaft and said second output shaft;

an electric motor for selectively driving a driveshaft;

a range shift mechanism for moving said range sleeve between its range positions in response to rotation of said driveshaft;

a clutch actuator assembly including a rotary drive member having rollers, and a non-rotary cam member having a tapered ramp surface in engagement with said rollers, said cam member being axially moveable relative to said friction clutch between a

retracted position whereat said friction clutch is released and an extended position whereat said friction clutch is engaged in response to rotation of said drive member;

a movement coordinating mechanism including a drive gear fixed to said driveshaft; and a rotary sector member having a gear segment meshed with said drive gear, said sector member having a slot and said drive member includes a follower pin extending into said slot, said slot permitting bi-directional rotation of said driveshaft for moving said range sleeve between its range positions while said sector member rotates relative to said drive member and maintains said cam member in its retracted position;

a mode selector for permitting selection of different four-wheel drive modes and generating a mode signal indicative of the drive mode selected;'

a sensor for sensing an operational characteristic of the vehicle and generating sensor signal; and

a controller receiving said mode signal and said sensor signal and controlling actuation of said electric motor in response thereto.

30. The transfer case of Claim 29 wherein a full-time four-wheel high-range drive mode is established when said motor rotates said driveshaft in a first direction to a position for locating said range sleeve in its high-range position and said slot has accommodated rotation of said sector member relative to said drive member and said cam member is located in its retracted position such that said friction clutch is released.

31. The transfer case of Claim 30 wherein a locked four-wheel high-range drive mode is established when said motor continues to rotate said driveshaft in said first direction to a position where said range shift mechanism maintains said range sleeve in its high-range position and said rotation of said sector member causes said follower pin to engage an end of said slot for rotating said drive member, such rotation of said drive member causes said rollers to ride on said tapered ramp surface of said cam member for moving said cam member from its retracted position to its extended position for engaging said friction clutch.

32. The transfer case of Claim 31 wherein an adaptive four-wheel high-range drive mode is established when said motor controls movement of said cam member between its retracted and extended positions in response to said sensor signals.